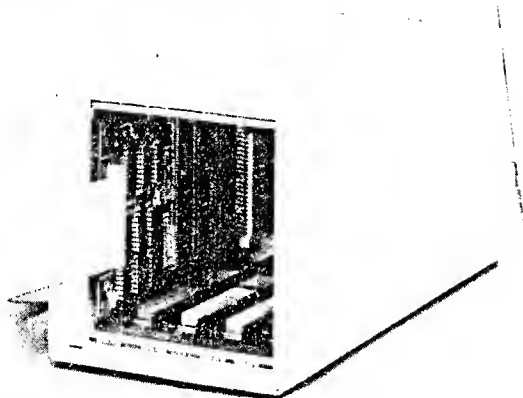


BEEBEX

General Purpose Eurocard Extension Unit
for the BBC Microcomputer 1 MHz Bus



Enclosed BEEBEX - power supply

- ★ Attaches to the BBC Micro's 1 MHz bus
- ★ Allows CUBE Eurocards to be used as an extension to the BBC Micro
- ★ Allows access to an external additional 64kB memory map

BEEBEX is probably the most versatile and comprehensive way of extending the BBC Microcomputer, because the CUBE range of Eurocards becomes available as hardware extensions using the 1 MHz bus interface.

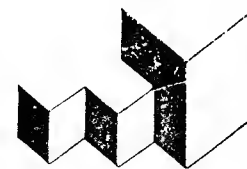
The CUBE range includes:

- 12 bit and 8 fast analog converters, DAC and ADC
- Digital i/o
- Serial i/o
- Heavy-duty industrial opto-isolated i/o
- Dynamic RAM memory and battery backed CMOS memory
- VDU interface that provides full colour at high resolution of 512 x 256 pixels
- In-circuit emulator
- ROM emulator
- Real-time clock
- Liquid crystal display
- Miniature printer

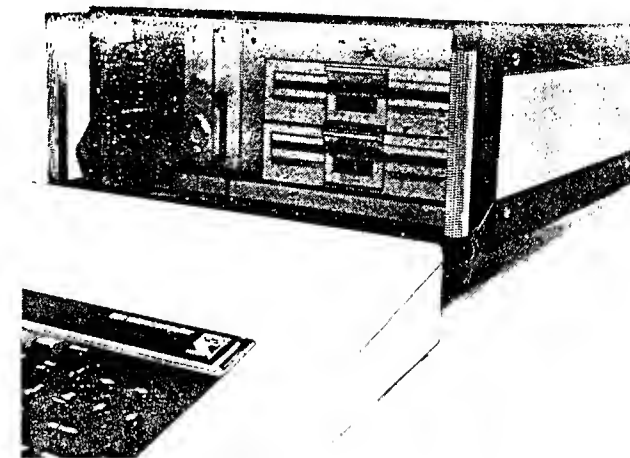
In addition, EuroBEEB is a single board computer which can support BBC BASIC, and can take over the function of the BBC after program development is complete.

Control Universal Ltd

BEEBEX USER MANUAL



Hardware Expansion Unit for the BBC Microcomputer

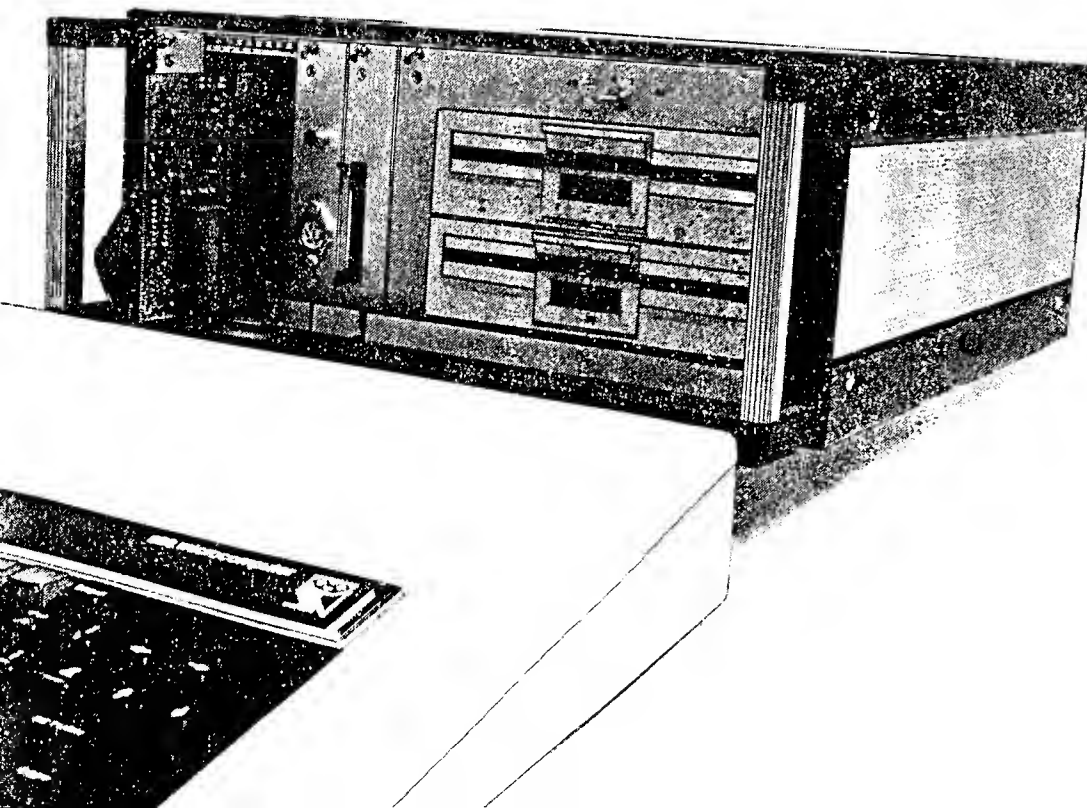


- ★ **HARDWARE EXTENSION TO THE BBC MICROCOMPUTER.**
BEEBEX provides a convenient, robust and versatile means of adding further hardware facilities to the BBC micro.
- ★ **ENTIRE CUBE RANGE CAN BE USED.**
All CUBE Eurocard computer modules to be used to extend the hardware capabilities of the BBC Microcomputer.
- ★ **EXCEPTIONALLY EASY TO USE** from the software point of view by use of a sideways ROM chip called *IO. See also separate data sheet on this product.
- ★ **AUTOBOOTING.** The BBC has an optional facility whereby a ROM (or EPROM) with address zero the Beebex memory map will be executed immediately upon switch-on. Such a ROM (or EPROM) can contain BASIC, machine code, or any other language for which there is an interpreter available in the machine.
- ★ **EXAMPLES OF USEFUL EXTENSIONS** include extra memory (including battery-backed CMOS), digital, analog and serial input/output channels and real-time calendar clock. CU-GRAPH, the true high resolution colour graphics display interface can be used, but does not come with software to be driven directly from the BBC operating system. This facility can be provided by the CUBE graphics terminal.
- ★ Industrial applications can use BEEBEX to develop control applications with the BBC machine, and then use EuroBEEB to replace the BBC in the target system.



BEEBEX USER MANUAL

Setting up Beebex
Accessing Beebex
Writing to Beebex
Reading from Beebex
Megabyte addressing
Megabyte writing
Megabyte reading
Accessing Beebex with *IO



SETTING UP THE BEEBEX

There are two versions of Beebex:-

- CUE2702 Beebex for rack mounting
- CUE2701 Beebex with 4 integral sockets for stand alone use

In addition there are a range of hardware and software options available

The two versions of Beebex are identical in use, the only difference being that the stand-alone version has four integral euro-sockets, while the rack version must plug into a Eurorack, which can have up to 16 sockets.

The 34 way cable supplied with Beebex is plugged into the 1MHz bus on the underside of the BBC micro.

As supplied, the address map on the Beebex is the standard 64KB of the typical 8 bit micro. To extend to 1MByte an extra latch chip must be fitted (see later). The whole of this 64KB is available to the user, so the CUBE modules to be used as BBC extensions can be set to any address demanded by the application. Note that a 64KB CU-DRAM memory card can be used in its entirety on its own, but if another device is to be used, the CU-DRAM must have one or more of its 4KB blocks deselected to make room for the extra device.

Future designs of CUBE modules will have 1 Megabyte addressing included as standard, which will allow 1 Megabyte of DRAM to be accessed simply by calling a megabyte address as shown later. Current designs are "paged". To call a particular CU-DRAM, a byte having a value in the range 0 to F (ie 0 to 16) is written to CU-DRAM hex address FFFF. The card having the code specified will be enabled and all other disabled. Note that any blocks disabled on the CU-DRAM map to accommodate other devices on the BEEBEX map must be disabled on all of the CU-DRAMs in use.

ACCESSING BEEBEX

Control Universal specify three methods of accessing Beebex.

***IO** The easiest method is to use the sideways ROM called *IO. A separate publication describes this in detail, but for brief details see a section at the end of this manual.

Direct. The direct method of access is explained in the following pages, and has the advantage of being the fastest means of access.

OSBYTE. The BBC micro has, as one of its many strengths, a properly defined means of accessing expansion units. There are two gaps in the BBC memory map specifically for this purpose.

The gap reserved for controlling expansion units is named "Fred", and that for communicating with them, "Jim". (for no obvious reason).

These gaps, and "Sheila", for internal devices, are defined on page 436 of the BBC user manual, as follows:

Name	Memory address range	OSBYTE call	Write
		Read	
FRED	&FC00-&FCFF	&92(146)	&93(147)
JIM	&FD00-&FD00	&94(148)	&95(149)
SHIELA	&FE00-&FEFF	&96(150)	&97(151)

Within the Fred i/o gap of 256 bytes, from hex FC00 to hex FCFF, allocations have already been made for specific purposes, such as the IEEE interface from hex FC20 to FC27. The gap reserved for Beebex is the "paging register", and is the last byte (hex FF) in Fred.

There are further bytes left free for the user to allocate, and one is employed by Beebex for the extended (1MB) addressing, and is the last but one byte, at hex FE.

To fully define a byte within a 1 Megabyte range, 20 bits are required, which can be broken down as follows:

1st 8 bits (lowbyte)	2nd 8 bits (midbyte)	3rd 4 bit (hinibble)
define byte within 256 bytes address with JIM	define byte of 256 bytes in 64KB map Beebex low latch	define map of 64KB within extended map of 1MB Beebex high latch

Thus the Jim memory gap of 256 bytes exists in the Beebex memory map, and on the BBC micro map simultaneously. However, from the point of view of the BBC, these 256 bytes are at hex FD00 to hex FDFF, while on the Beebex they are at hex QXY00 to QXYFF. (note that a five digit hex number is required to define a number within a 1MB range).

The value Q is the hinibble number on the Beebex high latch, and the value XY is the midbyte number on the low latch. The low byte number on the Beebex is exactly the same as the low byte number on the BBC.

To set the midbyte and hinibble numbers the required value is written to the latches by the BBC at hex FCFF and FCFE respectively. However, to further ease this operation, the operating system provides standard functions, called OSBYTE calls, with rules for setting the parameters to be used.

WRITING TO BEEBEX - within 64KB map.

DIRECT METHOD, BASIC

write the value hex JK to address hex XYNM in the Beebex map

```
jim = &FD00      define communications gap in memory
lowlatch = &FCFF  define low latch, to which midbyte will be written
?lowlatch = &XY   specify midbyte
jim?&NM = &JK     write the value hex JK to lowbyte hex NM
```

Note that lowlatch need be defined only once for access to all the bytes in Jim, so a loop to transfer 256 bytes of data would set up lowlatch to start with, and then would loop round the instruction accessing Jim, thus:

```
jim = &FD00      define communications gap in memory
lowlatch = &FCFF  define low latch, to which midbyte will be written
?lowlatch = &XY   specify midbyte
mem = &GHIJ       specify start address of memory in BBC
FOR A = 0 to 255  set up 256 long loop
jim?&(A) = ? (mem+A) write the value read from memory
                  to lowbyte incremented from 0 to 256
```

NEXT

e.g. write the value decimal 127 (= hex 7F) to location hex 6C54 in the Beebex 64 KB map.

```
jim = &FD00
lowlatch = &FCFF
?lowlatch = &6C
jim?&54 = &7F (or = 127)
```

DIRECT METHOD, MACHINE CODE

```
LDA #&XY      LDA #&6C
STA &FCFF     STA &FCFF
LDA #&JK      LDA #&7F (or LDA #127)
STA &FDNM     STA &FD54
```

STANDARD OSBYTE (OPERATING SYSTEM) CALL METHOD

The direct method does not obey operating systems rules, but is only very marginally slower than a memory transfer within the BBC. The OSBYTE call method will be much slower, but is recommended when use of a second processor is envisaged.

OS call method in BASIC

OSBYTE is a standard Machine Operating System call but is not a reserved BASIC word, so must be defined before use in a BASIC program.

To write the value hex JK in the memory address hex XYNM in Beebex.

```
OSBYTE = &FFFF4  OSBYTE exists at point in the OS ROM defined by &FFFF4
A% = 147          defined required function, ie write to Fred,
                  to set low latch to desired value
X% = &FF          specify last byte in Fred, ie hex FF, which paging reg.
Y% = &XY          specify byte to be written as midbyte to Beebex low latch
CAL OSBYTE        execute OSBYTE function as defined
```

```
A% = 149
X% = &NM
Y% = &JK
CALL OSBYTE
```

now write to Jim, to pass data byte from BBC to Beebex
define lowbyte in Jim, to correspond to lowbyte in Beebex
specify value to be written
execute OSBYTE function as defined

example: write the value 127 (hex 7F) in the Beebex memory location hex 6C54.

```
OSBYTE = &FFFF4
```

```
A% = 147
X% = &FF
Y% = &6C
CALL OSBYTE
```

```
A% = 149
X% = &54
Y% = 127
CALL OSBYTE
```

OS call method, machine code

method	example
LDA #147	LDA #147
LDX #&FF	LDX #&FF
LDY #&XY	LDY #&6C
JSR &FFFF4	JSR &FFFF4
LDA #149	LDA #149
LDX #&NM	LDX #&54
LDY #&JK	LDY #&7F (or LDA #127)
JSR &FFFF4	JSR &FFFF4

READING FROM BEEBEX

The choice of techniques is much the same as for writing to Beebex, with the same speed advantage of the "direct method", and with the same general principles for the OSBYTE call method.

Direct method, BASIC

To read the value in address hex XYNM in Beebex, and make it available as BASIC variable var1.

```
jim = &FD00      define communications gap in memory
lowlatch = &FCFF  define position of lowlatch in Fred
?lowlatch = &XY   define value of midbyte to be written in lowlatch
var1 = jim?&NM    put in variable var1 the value of the byte at &XYNM in Beebex
```

example: print the value in Beebex memory location hex 6C54.

```
jim = &FD00
lowlatch = &FCFF
?lowlatch = &6C
var1 = jim?&54
PRINT var1
```

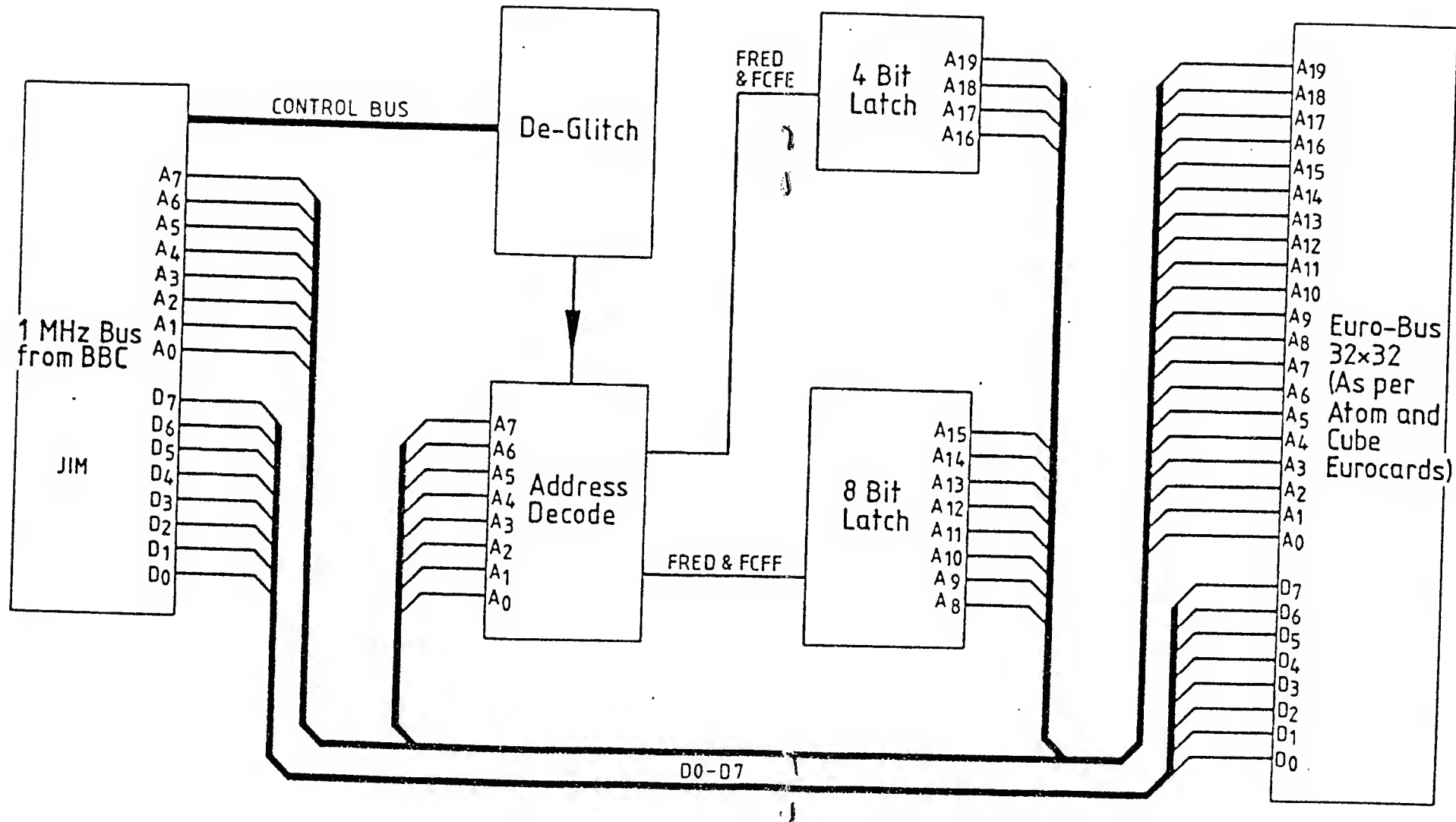
Read, direct method, machine code

method	example
LDA #&XY	LDA #&6C
STA &FCFF	STA &FCFF
LDA &FDNM	LDA &FD54

Value of specified byte is now in the accumulator of the cpu.

Read, OSBYTE method, BASIC

```
OSBYTE = &FFFF4  define OSBYTE
A% = 147          define the required function, ie write to Fred,
                  to set lowlatch to desired value
X% = &FF          define last byte in Fred, ie paging register
Y% = &XY          set value of midbyte to put in Beebex lowlatch
CALL OSBYTE       execute, to set midbyte to hex XY
A% = 148          define OSBYTE function, ie read from Jim
X% = &NM          define lowbyte in Jim, corresponding to lowbyte in Beebex
var1 = USR(OSBYTE) execute read function
```



value of byte read will now be found in varl. eg. PRINT varl will display the value found. (alternatively, PRINT USER(OSBYTE) will print the value directly)

example: read into BASIC variable varl the value in Beebex hex 6C54.

```
OSBYTE = &FFF4
A% = 147
X% = &FF
Y% = &6C
CALL OSBYTE
A% = 148
X% = &54
varl = USR(OSBYTE)
PRINT varl
```

Read, OSBYTE method, machine code

Read in to accumulator the value in specified Beebex memory location.

Method Example

Read from hex address XYNM Read from hex address 6C54

LDA #147	LDA #147	define OSBYTE function as write to Fred
LDX #&FF	LDX #&FF	specify last byte in Fred
LDY #&XY	LDY #&6C	specify midbyte address in Beebex
JSR &FFF4	JSR &FFF4	execute Fred write function
LDA #148	LDA #148	define OSBYTE function as read from Jim
LDX #&NM	LDX #&54	specify lowbyte address in Jim
JSR &FFF4	JSR &FFF4	execute read from Jim

The data read from Beebex is now in the Y register of the CPU.

MEGABYTE ADDRESSING

Before the one megabyte address capability can be used the extra address latch chip must be fitted. This device is a 74LS173 and is fitted in the socket provided marked IC4. Take care to fit the right way round; the dot on the chip should be by the marked corner on the white ic marking on the pcb. The standard CUBE data bus (which is generally compatible with the Acorn Eurocard bus) now has added the extra address lines A16 to A19 for megabyte addressing. With the addition of the extra latch above, these appear on pins 15b to 12b respectively, on the CUBE 64 way DIN connector.

MEGABYTE WRITING

Direct method, megabyte write, BASIC.

To write the value hex JK to the address in Beebex hex QXYNM. (note five figure address for 1 MB map). The top four bits which define the block of 64 KB within the 1MB map is called here the "hinibble".

jim = &FD00	define communications gap in memory
lowlatch = &FCFF	define low latch to which midbyte will be written
?lowlatch = &XY	specify midbyte
hilatch = &FCFE	define high latch to which hinibble will be written.
?hilatch = &0Q	specify hinibble
jim?NM = &JK	write value hex JK to address hex QXYNM.

Direct method, megabyte write, machine code.

LDA #&XY	load accumulator with midbyte
STA &FCFF	store it in lowlatch (on last byte in Fred)
LDA #&0Q	load accumulator with hinibble
STA &FCFE	store it in hilatch (on last but one byte of Fred)
LDA #JK	load accumulator with data value
STA &FDNM	store it in the NM byte of Jim

Example: write the value decimal 127 (hex 7F) to address hex 76C54 in the Beebex 1MB map

BASIC machine code

jim = &FD00	LDA #&6C
lowlatch = &FCFF	STA &FCFF

?lowlatch = &6C	LDA #&07
hilatch = &FCFE	STA &FCFE
?hilatch = &07	LAD #&7F
jim?&54 = &7F (or = 127)	STA &FD54

Megabyte write, OSBYTE method, BASIC

To write the value hex JK into the Beebex 1 MB map at address hex QXYNM.

OSBYTE = &FFF4	OSBYTE exists at the point in the OS ROM defined by &FFF4
A% = 147	define required function, ie. write to Fred
X% = &FF	to set low latch to desired value of hex XY
Y% = &XY	specify last byte of Fred, ie paging register
CALL OSBYTE	specify byte to be written as midbyte to Beebex low latch
	execute OSBYTE function as defined

X% = &FE	note that A% is still defined as write to Fred
Y% = &0Q	specify last but one byte of Fred, for hinibble latch
CALL OSBYTE	specify which of 16 blocks of 64KB within 1MB map
	execute OSBYTE function as defined

A% = 149	define OSBYTE function as write to Jim
X% = &NM	define byte address within Jim
Y% = &JK	specify data value to be written
CALL OSBYTE	execute function

Megabyte write, OS call method, machine code

LDA #147	define function as write to Fred
LDX #&FF	specify last byte of Fred
LDY #&XY	specify midbyte to be written to lowlatch
JSR #&FFF4	call OSBYTE
LDA #147	define function as write to Fred
LDX #&FE	specify last but one byte in Fred
LDY #&0Q	specify hinibble to be written to high latch on Beebex
JSR #&FFF4	call OSBYTE
LDA #149	specify function as write to Jim
LDX #&NM	specify byte within Jim to be written to
LDY #&JK	load data to be written
JSR #&FFF4	call OSBYTE and execute function

Example. Write the value decimal 127 (hex 7F) to location hex 76C54 in the Beebex 1MB memory map.

BASIC machine code

OSBYTE = &FFF4	LDA #147
A% = 147	LDX #&FF
X% = &FF	LDY #&6C
Y% = &6C	JSR &FFF4
CALL OSBYTE	

X% = &FE	LDA #147
Y% = &07	LDA #&FE
CALL OSBYTE	LDY #&07
	JSR &FFF4

A% = 149	LDA #149
X% = &54	LDX #&54
Y% = 127	LDY #&7F
CALL OSBYTE	JSR &FFF4

MEGABYTE READING Direct method, megabyte read, BASIC

To read the value in megabyte address hex QXYNM in Beebex, and make it available as BASIC variable var1.

```
jim = &FD00      define communications gap in memory
lowlatch = &FCFF  define position of lowlatch in Fred
?lowlatch = &XY   define value of midbyte to be written in lowlatch
hilatch = &FCFE   define position of high latch in Fred
?hilatch = &0Q    define value of hinibble to be put in high latch
var1 = jim?&NM    put in variable var1 the value of the byte at &QXYNM in Beebex
```

example: print the value in Beebex megabyte memory location 76C54.

```
jim = &FD00
lowlatch = &FCFF
?lowlatch = &6C
hilatch = &FCFE
?hilatch = &0Q
var1 = jim?&54
PRINT var1
```

Direct method, megabyte read, machine code

method	example
LDA #&XY	LDA #&6C value of midbyte
STA &FCFF	STA &FCFF write to paging register in Fred
LDA #&0Q	LDA #&07 value of hinibble
STA &FCFE	STA &FCFE write to hinibble register in Fred
LDA &FDNM	LDA &FD54 read from lowbyte in Jim

Value of specified byte is now in the accumulator of the cpu.

Megabyte read, OSBYTE method, BASIC

```
OSBYTE = &FFF4     define OSBYTE
A% = 147           write to Fred, to set lowlatch to desired value
X% = &FF           define last byte in Fred, ie paging register
Y% = &XY           set value of midbyte to put in Beebex lowlatch
CALL OSBYTE        execute, to set midbyte to hex XY

A% still defined as write to Fred
X% = &FE           define last but one byte in Fred for hinibble latch
Y% = &0Q           define value of hinibble
CALL OSBYTE        execute function to set hinibble to hex 0Q

A% = 148           define OSBYTE function, ie read from Jim
X% = &NM           define lowbyte in Jim, corresponding to lowbyte in Beebex
var1 = USR(OSBYTE)   execute read function
```

value of byte read will now be found in var1. eg. PRINT var1 will display the value found. (alternatively, PRINT USR(OSBYTE) will print the value directly).

example: read to BASIC variable var1 the value of Beebex 1MB address hex 76C54.

```
OSBYTE = &FFF4
A% = 147
X% = &FF
Y% = &6C
CALL OSBYTE
X% = &FE
Y% = &07
CALL OSBYTE
A% = 149
X% = &54
var1 = USR(OSBYTE)
PRINT var1
```

Megabyte read, OSBYTE method, machine code

Read in to accumulator the value in specified Beebex memory location.

Method	Example
Read from hex address XYNM	Read from hex address 6C54
LDA #147	LDA #147 define OSBYTE function as write to Fred
LDX #&FF	LDX #&FF specify last byte in Fred
LDY #&XY	LDY #&6C specify midbyte address in Beebex
JSR &FFF4	JSR &FFF4 execute Fred write function
LDA #148	LDA #148 define OSBYTE function as read from Jim
LDX #&NM	LDX #&54 specify lowbyte address in Jim
JSR &FFF4	JSR &FFF4 execute read from Jim

The data read from Beebex is now in the Y register of the CPU.

ACCESSING BEEBEX WITH *IO

*IO is a separate product with its own data sheet, and many more functions than just accessing Beebex. The following description covers only the Beebex-related topics of *IO.

*IO is a sideways ROM of the type now becoming increasingly popular for providing additional features on the BBC microcomputer. Other sideways ROMs include BASIC, Disk Filing System (DFS), Wordwise and Ultracalc.

*IO is a utility ROM, like the disk filing system ROM, and as such expects to be called from other sideways language ROMs. However, once called, vectors have been set up which direct all input and output calls to which ever i/o device has been specified to *IO.

The fundamental concept of *IO is that any area of memory outside the BBC computer is treated in the same way as a file on the file management system, ie like a disk file. Thus a named file can be opened, with a pointer within that file indicates where the current position is within that file, and with the ability to use the commands BPUT and BGET to write and read bytes from the Beebex memory map.

Example of the use of *IO.

In this example the BBC is connected via Beebex to the CUBAN-8 universal digital and analog interface. By writing an incrementing value to the 6522 (VIA) digital interface chip the on-board lead unit can be made to flash a binary representation of the numbers from 0 to 255. A time delay allows time to see the progressive changes.

10 *IO	call *IO
20 pb=OPENUP"BUS &0E00"	BUS is a keyword recognised by *IO, and when used sets a vector to the address next mentioned pb is the "handle" by which port B, which exists at hex 0E00 on the CUBAN-8, can be accessed.
30 ddr=OPENUP"BUS &0E02"	the data direction register (ddr) exists at hex 0E02
40 BPUT#ddr,&FF	write a byte to handle ddr, of value hex FF
50 FOR A=0 TO 255	commence loop of 256 cycles
60 BPUT#pb,A	write a byte to handle pb, of value A
70 PROCdelay	call procedure named "delay"
80 NEXT A	end of loop
90 GOTO 50	run program again
100 DEF PROCdelay	define procedure named "delay"
110 FOR D=1 TO 500:NEXT D	meaningless loop to cause delay
120 ENDPROC	